Attorney's Docket No.: 08305/048001/PBIT-0026.00/US

REMARKS

Reconsideration and allowance of the above referenced application are respectfully request.

Claims 6 and 8 stand objected to based on informalities. These informalities have been corrected herein by amendment.

All claims stand rejected as either being obvious based on or anticipated by Merrill, or Merrill in view of Fossum. This contention is respectfully traversed, and it is respectfully suggested that the rejection does not meet the patent office's burden of providing a prima facie showing of unpatentability.

Specifically, the present system defines a new way of obtaining an image on a chip. Conventional systems have obtained analog information indicative of the image, and converted that in formation to digital and output that digital information. In this system, however, the output from the image sensor is digitally accumulated on the chip. In fact, all of the claims now specify that the integration from the image sensor is carried out digitally. In other words, this system enables digital integration of the output from the image sensor. This can enables reduction of the size of the image sensor, since it allows digital integration of the information from the image sensor, rather than integrating that information in the substrate, as conventionally done. None of the cited prior art

is in any way suggestive of this feature. Therefore, for these reasons and as explained in further detail herein, it is respectfully suggested that all of the claims should be in condition for allowance.

An advantage of this system is that Merrill's digital operations can be used on the chip in order to obtain better image fidelity. For example, oversampling can be used to reduce quantization noise density. By storing the digital integrated value on chip, certain advantages can be obtained which are in no way taught or suggested by the cited prior art.

All of the claims specify storing digital information on the chip. Moreover, it is respectfully suggested that this is very different than what is done by the prior art, and that in fact the prior art never teaches storing digital information on the chip.

The rejection specifies that Merrill '541 teaches storing digital information in his memory 112. This is apparently based on the language of column 8. However, nowhere does '541 teach or suggest that digital values are integrated in the on chip memory as part of the image acquisition, as described.

Admittedly, Merrill teaches that certain digitized integration voltages are output. However, nowhere does it teach or suggest that a digital value is stored on the chip.

Admittedly, the secondary reference to Fossum shows putting a memory on the same chip as the image sensor. However, nowhere does any of the prior art teach that digital memory being on this same chip. All of the claims in the case should be allowable for this reason as well as on their own merits.

Specifically, claim 1 specifies that digital memory which should be allowable for reasons stated above.

Claim 3 specifies that the ABD converter is an oversampling converter. In this way, digital enhancement of the image can be carried out on the chip. Nothing in the prior art is in any way suggestive of this feature.

Claim 4 specifies that each pixel lacks sufficient capacity to integrate incoming photons for the desired time. This is again enabled by the digital integration of the information on the chip. Instead of integrating charge on the chip as in done by the cited prior art, this system uses a digital integration on the chip. As described above, this is in no way taught or suggested by the cited prior art.

Claim 6 should be allowable for similar reasons. Specifically, claim 6 defines a digital memory which digitally integrates signal. None of the cited prior art is in any way suggestive of digitally integrating the signal. Therefore, claim 6 should be allowable for these reasons. Claim 8

similarly specifies digital integration which is in no way taught or suggested by the cited prior art.

In view of the above amendments and remarks, all of the claims should be in consideration for allowance. A formal notice to that effect is respectfully solicited.

Please apply any charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

Date: 10/16/02

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Attached is a marked-up version of the changes being made by the current amendment.

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Version with markings to show changes made

In the claims:

Please amend the claims as follows:

1. (Amended) A digitally-integrating image sensor, comprising:

a semiconductor substrate;

a CMOS image sensor, formed on said semiconductor substrate, which produces image output information which, when sampled, indicates a value of a number of photons of an imaged scene which have impinged thereon; and

a digital memory, also formed on said semiconductor substrate, and connected to receive outputs from said CMOS image sensor, and to digitally integrate output values from said CMOS image sensor in the digital memory array.

2. A sensor as in claim 1, further comprising an analog to digital converter, receiving the outputs from said CMOS image sensor, converting said outputs to a digital form, and wherein said digital memory receives said digital form outputs.

3. A sensor as in claim 2, wherein said analog to digital converter is an oversampling converter.

4. A sensor as in claim 2, wherein each pixel of said CMOS image sensor is sufficiently small that it lacks sufficient capacity to integrate incoming photons for a desired integration time.

5. A sensor as in claim 2, further comprising a fixed pattern noise reduction circuit, between said CMOS image sensor and said analog to digital converter.

6. (Amended) A digitally-integrating image sensor, comprising:

a semiconductor substrate;

a CMOS image sensor, formed on said semiconductor substrate, which produces image output information, each pixel of said CMOS image sensor is sufficiently small that it lacks sufficient capacity to integrate incoming photons for a desired integration time, said image output information indicating a value of a number of photons of an imaged scene which have impinged thereon;

a noise reduction circuit, formed on said semiconductor substrate, and reducing an amount of noise in said image output information to form noise-reduced image output information;

an analog to digital converter, formed on said semiconductor substrate, and operating to convert said noise-reduced image output information to digital form noise-reduced image output information at specified intervals, each said specified interval being shorter than said desired integration time; and

a digital memory, also formed on said semiconductor substrate, and connected to receive said digital form noise-reduced image output information outputs from said CMOS image sensor, and to integrate said digital formed noise-reduced image output information from said CMOS image sensor in the digital memory array for a time equivalent to said desired integration time to output integrated digitally integrated [digital] image data.

7. A device as in claim 6, wherein said CMOS image sensor is an active pixel sensor.

8. (Amended) A method of acquiring an image, comprising:

forming a CMOS image sensor on a semiconductor substrate;

[uaing] <u>using</u> said CMOS image sensor to image a scene and to produce image output information;

sampling each pixel of said CMOS image sensor at a time period less than a desired integration time for each frame of the image;

converting each sampled pixel to digital;

storing the digitally-converted pixels in a digital memory, and using said digital memory to digitally integrate said digital pixels for the desired integration time, to thereby output a digitally integrated image.